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$$\therefore \beta dx = \frac{dy}{\beta\sqrt{[(\Delta+p)^2-(y+p)^2]}} = \frac{\dfrac{dy}{\Delta+p}}{\sqrt{1-\left(\dfrac{y+p}{\Delta+p}\right)^2}}.$$

$$\therefore \beta x = \sin^{-1}\left(\frac{y+p}{\Delta+p}\right)+c_2 \text{.........}(2).$$

Since $y=0$, for $x=l$, $c_2=\beta l-\sin^{-1}\left(\dfrac{p}{\Delta+p}\right)$.

$$\therefore \beta x = \sin^{-1}\left(\frac{y+p}{\Delta+p}\right)+\beta l-\sin^{-1}\left(\frac{p}{\Delta+p}\right) \text{.........}(3).$$

Since $y=\Delta$ for $x=\frac{1}{2}l$, we have by substituting in (3) and solving for Δ,

$$\Delta=p\left(\sec\frac{\beta l}{2}-1\right).$$

Substituting this value of Δ in (3), and reducing, we have

$$y+p=p\left(\frac{\sin\beta(l-x)+\sin\beta x}{\sin\beta l}\right).$$

II. Solution by SAUL EPSTEEN, Ph. D., The University of Chicago, and S. A. COREY, Hiteman, Iowa.

Substituting $z=p+y$, the equation takes the form $d^2z/dx^2=-\beta^2z$, of which $z=c_1\sin\beta x+c_2\cos\beta x$ (c_1 and c_2 being arbitrary constants) is the most general solution. The initial conditions are now $z=p$ for $x=0$, l; $dz/dx=0$, for $x=\frac{1}{2}l$. From the first, we have $c_2=p$, $c_1=p\tan\beta\frac{1}{2}l$, and therefore

$$y=-p+p\tan\beta\tfrac{1}{2}l\sin\beta x+p\cos\beta x.$$

It can now be verified that the condition $z=0$, for $x=l$ is fulfilled and is therefore superfluous in the enunciation of the problem.

The solution may evidently be transformed to the following form:

$$y=\frac{p(\cos\beta\frac{1}{2}l+\sin\beta\frac{1}{2}l\,\sin\beta x+\cos\beta\frac{1}{2}l\,\cos\beta x)}{\cos\beta\frac{1}{2}l}=\frac{p}{\cos\beta\frac{1}{2}l}[-\cos\beta\tfrac{1}{2}l+\cos\beta(x-\tfrac{1}{2}l)].$$

Also solved by G. W. Greenwood, G. B. M. Zerr, J. O. Mahoney, and W. W. Landis.

190. Proposed by SAUL EPSTEEN, The University of Chicago, Chicago, Ill.

$$\int_0^\infty \frac{\sin x\cos\beta x}{x}dx,\ \int_0^\infty \frac{\sin ax\cos x}{x}.$$

Solution by **IDA M. SCHOTTENFELS, M. A.**, New York, N. Y.

$$\int_0^\infty \frac{\sin x \cos\beta x}{x}dx=\tfrac{1}{2}\pi,\ \tfrac{1}{4}\pi,\ 0, \text{ according as } -1<\beta<+1, \beta=\pm1, +1<\beta<-$$

By making use of the trigonometrical formula

$$\sin x \cos\beta x=\tfrac{1}{2}[\sin(1+\beta)x+\sin(1-\beta)x] \tag{9}$$

$$\int_0^\infty \frac{\sin x \cos\beta x}{x}dx=A+B=\tfrac{1}{2}\left[\int_0^\infty\frac{\sin(1+\beta)x}{x}dx+\int_0^\infty\frac{\sin(1-\beta)x}{x}dx\right].$$

$A=\int_0^\infty\frac{\sin(1+\beta)x}{x}dx=+\frac{1}{2}\pi,\ 0,\ -\frac{1}{2}\pi$ according as $(1+\beta)>0$, $(1+\beta)=0$, $(1+\beta)<0$.

$B=\int_0^\infty\frac{\sin(1-\beta)x}{x}dx=+\frac{1}{2}\pi,\ 0,\ -\frac{1}{2}\pi$ according as $(1-\beta)>0$, $(1-\beta)=0$, $(1-\beta)<0$.

$A+B=\frac{1}{2}\pi$ where $-1<\beta<+1$. $A+B=\frac{1}{4}\pi$ where $\beta=\pm1$. $A+B=0$ where $+1<\beta<-1$.

$\int_0^\infty\frac{\sin\alpha x \cos x}{x}dx=\frac{1}{2}\pi,\ \frac{1}{4}\pi,\ 0,\ -\frac{1}{4}\pi,\ -\frac{1}{2}\pi$ according as $\alpha>1$, $\alpha=1$, $-1<\alpha<+1$, $\alpha=-1$, $\alpha<-1$.

By making use of the trigonometrical formula

$$\sin\alpha x \cos x=\tfrac{1}{2}[\sin(\alpha+1)x+\sin(\alpha-1)x] \tag{8}$$

$$\int_0^\infty\frac{\sin\alpha x \cos x}{x}dx=C+D=\tfrac{1}{2}\left[\int_0^\infty\frac{\sin(\alpha+1)x}{x}dx+\int_0^\infty\frac{\sin(\alpha-1)x}{x}dx\right].$$

$C=\int_0^\infty\frac{\sin(\alpha+1)x}{x}dx=\frac{1}{2}\pi,\ 0,\ -\frac{1}{2}\pi$ according as $(\alpha+1)>0$, $(\alpha+1)=0$, $(\alpha+1)<0$.

$D=\int_0^\infty\frac{\sin(\alpha-1)x}{x}dx=\frac{1}{2}\pi,\ 0,\ -\frac{1}{2}\pi$ according as $(\alpha-1)>0$, $(\alpha-1)=0$, $(\alpha-1)<0$.

$C+D=\frac{1}{2}\pi$ where $\alpha>1$. $C+D=\frac{1}{4}\pi$ where $\alpha=1$. $C+D=0$ where $-1>\alpha<+1$. $C+D=-\frac{1}{4}\pi$ where $\alpha=-1$. $C+D=-\frac{1}{2}\pi$ where $\alpha<-1$.

We now set the integral in (I) and (II) equal to a function of the parameters α and β thus

$$\int_0^\infty\frac{\sin\alpha x \cos x}{x}dx=\psi(\alpha),\quad \int_0^\infty\frac{\sin x \cos\beta x}{x}dx=\chi(\beta),$$

and trace the resulting curves.

The finite discontinuities occur in both cases for the parameters α, $\beta = \pm 1$.

Also solved by M. E. Graber, G. W. Greenwood, F. D. Posey, S. A. Corey, G. B. M. Zerr, and J. O. Mahoney.

MECHANICS.

170. Proposed by **M. E. GRABER, A. M.**, Heidelberg University, Tiffin, Ohio.

Prove that the moment of inertia of an ogival head rotating about its geometrical axis is $\frac{\pi w}{g}\int_0^{R\sqrt{(4n-1)}} y^4 dx$, where w is the weight in pounds of a cubic foot of material, R the radius of the base of the ogive, and n the diameter of projectile.

Solution by **LYTLE BROWN**, Lehigh University, and the **PROPOSER**.

An ogival head is one-half the solid generated by the revolution of a segment of a circle about its chord. The equation of the generating curve is $y = \sqrt{(4n^2R^2 - x^2)} - (2n-1)R$, the origin being the center of the base of the ogive. If $y=0$, the resulting value of x is the length of the head, that is, the length of the head is $R\sqrt{(4n-1)}$. The moment of inertia of an elementary cylinder about the axis of x is $4\pi y^2 \frac{\omega}{g}.y^2 dx$, or $dI = \frac{\pi\omega}{2g}y^4 dx$.

$$\therefore I = \frac{\pi\omega}{g}\int_0^{R(\sqrt{4n-1})} y^4 dx.$$

AVERAGE AND PROBABILITY.

155. Proposed by **E. B. WILSON, Ph. D.**, Yale University.

The game of craps is played with two dice. If the player throws 7 or 11 on the first throw he wins. If he throws 12, 2, or 3 he loses. If the player throws any other number, that is to say, 4, 5, 6, 8, 9, 10, he is obliged to continue throwing until he throws that number again or until he throws 7. If he succeeds in throwing his first throw before he does 7, he wins—otherwise he loses. Required the odds against him. (Note that he can continue throwing indefinitely without getting either his original throw or the 7).

REMARK. A correct solution of this problem is given by Dr. Zerr, in Vol. X, No. 3, p. 81. Mr. J.E. Sanders sent in a different solution, his answer being $\frac{244}{495}$, in favor of the player.

Problem 131 should be numbered 158. Three solutions of this problem have been received, none of which agree.

Problem 157 should be numbered 159,

MISCELLANEOUS.

144. Proposed by **IRA M. DeLONG**, Professor of Mathematics in the University of Colorado, Boulder, Col.

Determine the number of distinct spherical polygons of n sides formed by arcs of n given great circles on a sphere, each arc to be greater than 0 degrees, and less than 360 degrees, and no two sides of any polygon to lie an the same circle.